CLAIMS

1. A method for manufacturing a surface-alloyed cylindrical, partly cylindrical or hollow cylindrical structural member where an energy beam having a linear radiation area, hereinafter called a linear focus, is directed onto a workpiece surface whereby the workpiece surface is melted and a hard-material or alloy powder is fed into the molten surface,

   characterised in

   that

   a) in the zone of incidence of the energy beam there is formed a locally bounded melting bath with a heating and melting front, a solution zone and a solidification front,
   b) at the side of the energy beam the hard material powder is deposited via a conveyor device in the direction of gravity and is supplied co-ordinated with the feed movement of the workpiece in a width which corresponds to the width of the linear focus and a layer height of 0.3 - 3 mm is thereby produced,
   c) the hard-material powder supplied to the workpiece surface in the heating front of the melting bath is heated by an energy beam at a wavelength of 780 - 940 nm and in contact with the liquefied matrix alloy the powder is immediately dissolved in the melting bath,
   d) convection is produced in the solution zone by the energy beam having a specific power of at least

10^4 W/cm^2, so that the homogenisation process in the melting zone is accelerated,

e) where the linear focus acts on the solution zone until the hard material powder is uniformly distributed in the melting bath,

f) the uniformly distributed powder material in front of the energy beam, which has gone into solution metallurgically in the solution zone, is subjected to directional solidification in the solidification front at a high cooling rate of 200 - 600 K/sec at a feed rate of 500 - 10,000 mm/min.

2. The method according to Claim 1,

characterised in

that the hard material powder in process steps b) - f) is silicon powder with a grain diameter of 40 - 90 μm.

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3. ~~The method according to one of the preceding Claims,~~

~~characterised in~~

~~that the energy beam is split before the zone of incidence where a first part beam is deflected into the heating zone and melting zone and a second part beam is deflected behind the solidification front for thermal structural treatment.~~

4. The method according to Claim 3,

characterised in

that the workpiece is constructed as a hollow cylinder and rotates about the energy beam in the downhand position during the coating whereby the energy beam which is held in a fixed position relative to the direction of rotation, achieves a continuous feed movement during the rotation in the direction of the axis of rotation to produce a flat alloying zone.

9. The method according to one of the preceding Claims,

characterised in

that at the beginning of alloying the energy beam has a point structure and continually increases in size together with the quantity of powder until it has reached the complete linear focal width after a rotation of the workpiece.

10. The method according to one of the preceding Claims,

characterised in

that at the end of the alloying during the last rotation of the workpiece the linear focal width and the quantity of powder are continuously reduced to zero.

11. The method according to one of the preceding Claims,

characterised in

that a hollow cylinder made of Al or Mg alloys having a bore diameter of 60 - 120 mm is treated at a depth of up to 200 mm.

that the second part beam is directed behind the solidification front onto the workpiece surface at a specific power of < 1 kW/mm^2 to control the precipitation structure.

5. The method according to Claim 2,

characterised in

that the time of action of the energy beam in the melting bath for dissolving and homogeneously distributing primary precipitated Si phases is between 0.01 and 1 second.

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6. The method according to one of the preceding Claims,

characterised in

that a ≥3 kW diode laser with a variable optical system to adjust the linear focal width of 4 - 15 mm is used to form the energy beam.

7. The method according to one of the preceding Claims,

characterised in

that before the beginning and at the end of a coating the linear focal width of the energy beam and the quantity of powder is reduced transverse to the feed direction.

8. The method according to one of the preceding Claims,

characterised in

12. A device for implementing the method, consisting of a workpiece clamping device (1), on which a workpiece is aligned and clamped above index holes and/or above working surfaces, onto whose surface a powder supply (5) and a focusable beam from a beam head (4) are directed,

characterised by an energy beam and powder supply device inserted into an axis of the cylinder, where the energy beam is directed as a linear focus onto the workpiece rotating in the downhand position at an angle ±a = 0 - 45° to the gravity vector.

13. The device according to Claim 12,

characterised in

that several energy beam units staggered relative to one another are directed onto the working surface of the workpiece rotating in the downhand position, where the energy beam units (8b, 8a) sweep the working surfaces one after the other and rectilinearly like tracks.

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14. The device according to one of the preceding Claims,

characterised in

that the energy beam units next to one another sweep several lines of the working surface simultaneously, if necessary with several powder supply devices.

15. The device according to one of the preceding Claims,

characterised in

that the energy beam unit is located in a fixed position relative to the direction of rotation inside the rotatable workpiece clamping device connected to a drive unit where the energy beam is directed from the energy beam head onto the workpiece surface,

that the powder supply device is located beside the energy beam device.

16. The device according to one of the preceding Claims,

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characterised in

that the powder is blown onto surface facing the beam either in the direction opposite to the feed direction through the beam into the melting zone or is sprinkled loosely in the direction of gravity before or in the melting zone in front of the energy beam.

17. The device according to one of the preceding Claims,

characterised in

that the drive unit for the workpiece makes it possible to achieve a variable rotation speed where the feed direction of the energy beam device and the powder supply in the direction of the axis of rotation are combined with the rotation speed of the workpiece to achieve spiral or other geometrical guidance of the linear focus onto the workpiece surface.

18. The device according to one of the preceding Claims, especially for engine blocks, consisting of a rotatable clamping device (1) for a cylinder block (2), a laser treatment unit (3) with a beam head (4), which is connected to a powder supply device (5), and a transfer unit which positions the cylinder block (2) in front of the laser beam treatment unit (3) and a drive (6) to move the transfer unit along a transfer axis (10),

characterised in

that the clamping plane of the clamping device (1) is aligned perpendicular to the beam direction of the laser unit (3),

that the laser unit (3) can be displaced perpendicular to the clamping plane of the clamping device (1) where the beam direction is perpendicular to the transfer axis (10) at an angle ±a = 0 to 45° to the gravity vector,

that the powder supply (5) either opens directly in the beam direction of the laser unit (3) or (seen in the feed direction) shortly before the beam incidence zone (12).

19. The device according to one of the preceding Claims,

characterised in

that a laser treatment unit (3) consists of several beam devices which can be inserted in a cylinder bore whereby several working surfaces are arranged

on the cylinder wall (seen in the direction of the cylinder axis).

20. The device according to one of the preceding Claims,

characterised in

that the powder supply device (5) consists of several feed devices which can be inserted in a cylinder bore where the feed openings are arranged one behind the other (seen in the direction of the cylinder axis).

21. The device according to one of the preceding Claims,

characterised in

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that the powder supply device consists of a screw conveyor, a conveyor belt or a vibrating conveyor chute.

VAW aluminium AG
Georg-von-Boeselager Str. 25
53117 Bonn

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MW/scb (al101705)
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METHOD FOR MANUFACTURING A SURFACE-ALLOYED CYLINDRICAL, PARTLY CYLINDRICAL OR HOLLOW CYLINDRICAL STRUCTURAL MEMBER AND DEVICE FOR IMPLEMENTING THE METHOD

SUMMARY

The invention relates to a method for manufacturing a surface-alloyed cylindrical, partly cylindrical or hollow cylindrical structural member where in the zone of incidence of the energy beam there is formed a locally bounded melting bath with a heating and melting front, a solution zone and a solidification front. At the side of the energy beam the hard material powder is deposited via a conveyor device in the direction of gravity and is supplied co-ordinated with the feed movement of the workpiece in a width which corresponds to the width of the linear focus and a layer height of 0.3 - 3 mm is thereby produced. The hard-material powder supplied to the workpiece surface in the heating front of the melting bath is heated by an energy beam at a wavelength of 780 - 940 nm and in contact with the liquefied matrix alloy the powder is immediately dissolved in the melting bath. Convection is produced in the solution zone by the energy beam having a specific power of at least 10^4 W/cm^2, so that the homogenisation process in the melting zone is accelerated, where the linear focus acts on the solution zone until the hard material powder is uniformly distributed in the melting bath. In front of the energy beam the uniformly distributed powder material, which has gone into solution metallurgically in the solution zone, is subjected to directional solidification in the

solidification front at a high cooling rate of 200 - 600 K/s at a feed rate of 500 - 10,000 mm/min. The invention also relates to a device for implementing the method, consisting of a workpiece clamping device, on which a workpiece is aligned and clamped above index holes and/or above working surfaces, onto whose surface a powder supply and a focusable beam from a beam head are directed.

Figure 1